

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF TWO SYMPATRIC *RUTILUS* (RAFINESQUE, 1820) SPECIES FROM LAKE SKADAR (MONTENEGRO)

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Abstract - Two species from the genus *Rutilus* (Rafinesque, 1820), *R. prespensis* and *R. albus* inhabit Lake Skadar. The conditional factor (K) and length-weight relationships (LWRs) of 165 specimens were studied from January 2008 to January 2009. Based on the LWRs, it was found that *R. albus* exhibited isometric growth to the stage of sexual maturity, after which it exhibited allometric growth; *R. prespensis*, exhibited only allometric growth. The conditional factor for the both species significantly differed between months. The spawning period of *R. albus* began in February, while for *R. prespensis* it was April-May.

Key words: Balkan, Cyprinidae, isometric growth, allometric growth,

INTRODUCTION

The genus *Rutilus* (Rafinesque, 1820) belongs to the family Cyprinidae and it is widely distributed in Eurasia, whereby 16 species have been described in Europe (Kottelat and Freyhof, 2007). The basin area of the Adriatic Sea is inhabited by five species (Kottelat and Freyhof, 2007). The taxonomic status of the species of the genus *Rutilus* inhabiting Lake Skadar was unclear for many years. Recently Milošević et al. (2011) showed that the Lake Skadar basin is inhabited by two species from the genus *Rutilus*: *R. prespensis* (Karaman, 1924) (local name yellow roach), and *R. albus* Marić, 2010 (white roach).

The species from the genus *Rutilus* are one of the most numerous fish species in Lake Skadar. Although they are economically less important, knowledge of their ecology has scientific as well as practical importance, having in mind that the number of these spe-

cies increases (especially *R. prespensis*), whereas the number of *R. albus* decreases (Marić, 2010). However, the state of *R. albus* in the watershed of Lake Skadar has yet to be determined.

The condition factor (K) gives information when comparing two populations living in certain feeding, density, climate, and other conditions; when determining the period of gonad maturation; and when following up the degree of feeding activity of a species to verify whether it is making good use of its feeding source (Weatherley, 1972). The morphometric relationships between length and weight (LWRs) can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King, 2007). In addition, they may also help to determine whether somatic growth is isometric or allometric (Ricker, 1975), as well as to describe seasonal variations of growth within species (Bobori et al., 2010).

The aim of the present paper was to collect the first comprehensive data of the LWR and K of endemic *Rutilus* species (*R. albus* and *R. prespensis*) from Lake Skadar, Montenegro. At the same time, this paper provides the first information on the ecology of these endemic taxa.

Study area

The Lake Skadar drainage basin is located between 18°41' and 19°47' east and between 42°58' and 40°10' north. Lake Skadar, located in a karstic area in the outer part of the southeastern Dinaric Alps, is the largest of the Balkan lakes and has a surface area that fluctuates seasonally from approximately 370 to 600 km².

The Lake's water level also varies seasonally from 4.7 to 9.8 m above sea level. The lake extends in a NW-SE direction, and it is approximately 44 km long. The Bojana River connects the lake with the Adriatic Sea, and the Drim River provides a link with Lake Skadar. The exact origin of the lake is unknown but it probably originated by solution and tectonic processes during the Pleistocene (Stanković, 1957).

The southern and southwestern sides of the lake are rocky, barren and steep, with bays in which sub-lacustrine springs, known as "okos", are usually to be found. On the northern side, there is an enormous inundated area, the boundaries of which change as water levels fluctuate. The climate at the Lake Skadar drainage basin is typically Mediterranean, with a long, hot summer at lower and medium altitudes and a short winter with heavy and abundant rainfalls.

MATERIALS AND METHODS

A total of 165 specimens of *Rutilus* spp. from Lake Skadar were collected from January 2008 to January 2009 using 14-16 mm mesh-sized sinking gill nets and electro-aggregates, depending on the place of sampling. All individuals (preserved frozen) were measured for total length (TL, in cm) and weight (W, total wet weight in g) to the nearest 0.01 g. The total length (TL) of each fish (measured to the near-

est 0.02 mm) was taken from the tip of the anterior part of mouth to the end of the caudal fin. The condition factor (K) was estimated from the mathematical function:

$$K = 100WL^{-3}$$

where K is the condition factor, W is total weight of body and L is the total body length (in cm).

The following mathematical function was used for estimating the LWRs (Ricker, 1975):

$$W = aL^b$$

where W is total body weight (in gr), L is the total body length (TL) (in cm), and *a* and *b* are the coefficients of the functional regression between *W* and *L*. An allometric coefficient *b* value larger or smaller than 3.0 shows allometric growth, or isometric growth when it is equal to 3.0 (Bagenal and Tech, 1978). The values of the parameters (*a* and *b*) were estimated by linear regression analysis based on the log transformed equation $\log w = \log a + b (\log l)$ (Ricker, 1975). The determination coefficient (*r*²) was used as an indicator of the quality of the linear regressions.

RESULTS AND DISCUSSION

The sample size, the minimum, maximum and mean lengths and weights, the values of *a* and *b*; the coefficient of determination *r*² and condition factor for *Rutilus albus* and *R. prespensis* are given in Table 1. The calculated allometric coefficient *b* among study species varied from 3.0147 for *R. albus*, to 3.3589 for *R. prespensis*. These values are within the limits (2 and 4) reported by Tesch (1971) for most species. The length-weight relationship in fish can be affected by several factors, including habitat, area, seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observed length ranges of the specimen caught (Tesch, 1971), all of which were not accounted in the present study. The growth model of *R. albus* was determined using two data sets. The analysis of the

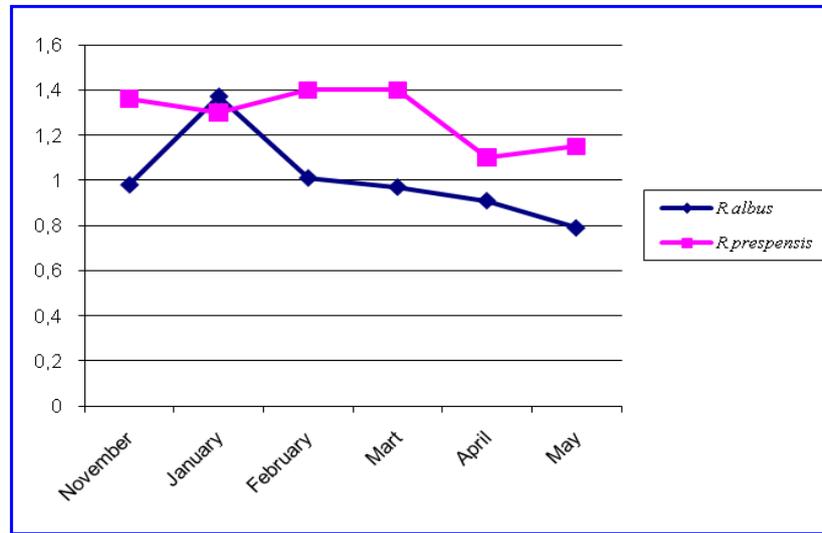


Fig. 1. Monthly condition factors of populations of *R. albus* and *R. prespensis* in Lake Skadar.

LWRs of specimens without stomach showed that *R. albus* exhibited isometric growth ($b=3.0147$) until the stage of sexual maturity, while the b values of 3.4003 for sexually mature individuals denoted allometric growth model (Table 1). In both cases, the r values (0.93) indicate an almost perfect correlation between length and weight values. This variation in the b exponents for the same species is obviously attributed to the differences in age and stage of maturity. Growth increment, differences in age and stage of maturity, food, as well as environmental conditions such as temperature, salinity and seasonality can also affect the value of b for the same species (Weatherley and Gill, 1987).

The b value of 3.3589 (Table 1) for *R. prespensis* indicates positive allometric growth. The r value of 0.92 indicates a high correlation degree of measured characters of length and weight. Information regarding data of LWRs species from the genus *Rutilus* from the Balkan Peninsula is insufficient. The length-weight relationships information available in Fish Base (Froese and Pauly, 1987) exist only for the *R. rutilus* ($a=0.0021$; $b=3.233$) from River Neretva. Bobori et al. (2010) also recorded the positive allometric in *R. prespensis* (Karaman, 1924) ($a=0.0060$; $b=3.283$) from Mikri Prespa (Greece). Our results

for the studied species presented in this paper shows that the b values were generally in agreement with these results.

Fig. 1 shows the monthly values of the condition factors for *Rutilus albus* and *R. prespensis*. The lowest condition factor value (0.79) for *R. albus* was recorded in May and the highest (1.37) in the January. For the *R. prespensis*, the lowest condition factor value (1.1) was recorded in April and May, and the highest (1.4) in February and March. Based on the obtained values it can be concluded that the spawning period of *R. albus* began in February. The temperatures during the reproduction period of *R. albus* were $< 15^{\circ}\text{C}$. For *R. prespensis*, the spawning period started in April at temperatures $> 15^{\circ}\text{C}$. These results are consistent with our preliminary outcomes of analysis of the reproductive cycle and spawning period of these species, which are both based on the histological analysis of the gonads (Milošević, unpublished data). K values (Table 1) showed that both species were in good condition, which indicated to well-preserved state of their habitats and sufficient food supply. Having in mind the fact that there is no information about these species in either Fish Base or published papers on their ecology, this paper represents a significant step toward better knowledge of

Table 1. Summary table of condition factor (K) and estimated parameters of the length-weight relationship ($W = aL^b$) for species from the genus *Rutilus* from Lake Skadar. Shown are sample size (N); the minimum, maximum and mean values of total length (TL, in cm) observed; the minimum, maximum and mean values of total weight (in gr) observed; parameters of the relationship (a and b); coefficient of determination (r^2).

Population	N	TL range		Total weight		L-W relationship			K	
		Min-max	mean	Min-max	mean	a	b	r^2		
<i>R. albus</i>	without stomach	45	8.5-20.37	13.18	5.5-88.1	23.37	0.0084	3.0147	0.9262	1.003
	with stomach (mature individuals)	35	10.54-23.32	14.29	11.23-185.5	40.11	0.0035	3.4003	0.935	
<i>R. prespensis</i>	with stomach (mature individuals)	120	11.19-20.58	14.47	16.5-165.9	42.88	0.0046	3.3589	0.8575	1.29

the ecology of these taxa and at the same time provides a contribution to this database.

Despite the general attention that has been given to Lake Skadar, a biologically rich lacustrine system, it is apparent that a great deal of knowledge about the most basic units of biodiversity, even among fish species, is still lacking. For these reasons, it is necessary to perform more detailed analysis of the differentiation level of these sympatric species, especially when it comes to feeding and the degree of reproductive isolation.

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